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OPERATIONAL YIELDS RESULTING FROM TYPICAL SILVICULTURAL TREATMENTS UNDER FRDA

by
Stephen Smith

FOREST RESOURCE DEVELOPMENT AGREEMENT

Canada

BC

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TABLE OF CONTENTS

Page

INTRODUCTION 1

EXISTING LITERATURE AND STUDIES 2
Planting of Backlog Areas 2
Brushing and Weeding and Conifer Release 2
Juvenile Spacing 3
Fertilization 10
Spacing and Fertilization 11
Growth Response Conclusions 12

METHODS 14
The PROGNOSIS Model 14
Habitat Types and B.C. Biogeoclimatic Zones 16
Using PROGNOSIS 19

RESPONSE ESTIMATES FOR INTERIOR SPECIES 21
Treatment Definitions 21
Running PROGNOSIS 22

RESPONSE ESTIMATES FOR COASTAL SPECIES 23
Treatment Definitions 23
Running PROGNOSIS 24

OPERATIONAL CONDITIONS 25
Responses 26

REFERENCES 29

APPENDIX 1: RESULTS 32

INTRODUCTION

Under the Forest Resources Development Agreement (FRDA) investments are made which affect the quantity and quality of timber which will be available for harvest in the future. This report provides estimates of the biological responses to different treatments (investments) applied under FRDA.

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EXISTING LITERATURE AND STUDIES

There is a great deal written about growth and yield responses to silvicultural treatments. At the same time response estimates from well-designed field experiments over a long time period are rare. Most information is available for thinning. Some is available for fertilization and very little can be found for other silvicultural practices. The following pages discuss responses to:

- planting of backlog areas
- brushing and weeding
- conifer release
- juvenile spacing
- fertilization
- spacing combined with fertilization

PLANTING OF BACKLOG AREAS

Once the site has been prepared, planting of backlog areas provides the potential for high yields from well-stocked plantations. The alternative is a long delayed and much lower yield from irregularly stocked natural stands. Planting backlog areas produces a large yield gain and significantly shortens the time to harvest. Successful planting provides good regular stocking. Planting also gives the opportunity to gain from genetically improved stock. Smith (1988) provided estimates of regeneration delays and natural yields on untreated backlog forest land.

BRUSHING AND WEEDING AND CONIFER RELEASE

These practices remove competing vegetation. Brushing and weeding removes the competing vegetation which grows up around young seedlings. Brushing and weeding prevents the slowing of seedling growth and loss of stems due to competition from other vegetation. Competing vegetation is present to some degree on all reforested areas. Brushing and weeding treatments are applied only when reduced growth rates and increased mortality will happen otherwise.

The competing vegetation may completely overtop the young commercial trees. On the coast, older trees may form a canopy over the commercial understory. In the interior, tall brush species may overtop and suppress the growth of young forest trees. In the Prince George Forest Region high brush forms over spruce regeneration. When overtopped, almost the entire coniferous stand may be lost resulting in deciduous stands or non-

commercial brush areas. Boateng (1984) estimated the extent of forest brush problems in British Columbia. He also made estimates of the possible yield gains if all brush areas were replaced with commercial stands.

The vegetation management literature is concentrated on the methods of removing the competing vegetation. The yield gain from conifer release is close to the difference between a well stocked second growth stand and no yield at all. Yield gains from removing severe brush and weed competition are not as high. A literature search found no good long term response data from well designed field experiments for yield gains from brushing and weeding.

JUVENILE SPACING

Evert (1971) reviewed past studies on the initial spacing of plantations. Spacing affects the growing space available to each tree. This in turn affects the sunlight, moisture and nutrients available to the tree. Frost and wind exposure are also affected.

Wood structure is affected by spacing because the average ring width increases as trees per hectare decreases. The following discussion on spacing and wood quality is taken from Evert (1971).

Rate of Growth and Wood Quality

Ring width in itself has an important influence on the quality of wood through its association with uniformity and texture, which in turn affect such properties as stability, machinability, resistance to abrasion and wear, and resonance (Fielding, 1967). Timber with alternating wide bands of spring and summer wood has a very uneven texture and is very unsatisfactory for any type of joinery work (De Villiers et al, 1961). Knigge (1958) found that a feature of the disappointing quality of the wood produced in some German plantations of Pseudotsuga menziesii was the great variation in ring width during the first 40 years. He suggested, as a means of producing better wood, that the species be grown in dense pure stands or under pine. Also, Kotzenburg (1954) showed that high quality logs of Pinus sylvestris can be produced on good (broadleaf forest) sites, provided that attention is given to close spacing and shading in youth (Fielding, 1967).

An indirect but important economic result of wide rings is the effect on log diameter, which influences the market value of the logs (Fielding, 1967).

Many workers have found little, if any, relation between ring width and specific gravity of softwoods (Turnbull and du Plessis, 1946;

Turnbull, 1947; Spurr and Hsiung, 1954; Larson, 1957; Jayne, 1958; Echols, 1959; Fielding and Brown, 1960; Nicholls and Fielding, 1965), although the specific gravity of the corewood may be strongly influenced by ring width (Fry and Chalk, 1957). In some cases ring width and specific gravity of softwoods have been found to be associated, increasing ring width tending to be associated with decreasing specific gravity, but the effects have been found to be small, particularly when compared with the variations in specific gravity with position in trunk and with age (Fielding, 1967).

The specific gravity of hardwoods is affected much more, in general, by ring width than is that of conifers, the narrow ring width, particularly in ring-porous hardwoods, generally being associated with reduced specific gravity (Fielding, 1967).

High specific gravity is associated with high strength values and other desirable properties - longer tracheids, smaller micellar angle, lower longitudinal shrinkage, and absence of serious spiral grain in the denser 'mature' wood of many conifers (Fielding, 1967).

The variations in fibre length associated with ring width have been found to be much smaller than those associated with age, and within-tree variation (Hata, 1949a; Kennedy and Wilson, 1954; Spurr and Hyvarinen, 1954; Ch'Eng et al, 1963; Dinwoodie, 1963), and greater in conifers than in hardwoods (Fielding, 1967).

Iablokoff (1955) found for Norway spruce that in narrow annual rings all the tracheids tend to be rectangular in cross section and to vary little in radial and tangential diameters, whereas with increasing ring width a greater proportion tend to be hexagonal, and variations in diameter increase. Johnson (1942) found that the average fibre diameter of some hybrid poplars was positively correlated with ring width, although he concluded that rapid growth had no serious effect on wood quality (Fielding, 1967).

Variations in ring width can have an appreciable influence on the chemical composition of wood. For example, Worster and Sugiyama (1962) concluded from a study of 200 trees of five species in British Columbia that as conditions for growth become more favourable the proportion of lignin falls. Hata (1949b) found that fast-growth trees of Pinus densiflora had a higher cellulose content than slow-grown, although the differences were too small to appreciably affect pulp quality (Fielding, 1967).

In a study on the influence of increased growth rate on the following properties of mature wood of Norway spruce and Scots pine: summer-wood percent, specific gravity, extractive content, fibre diameter, fibre wall thickness and fibre length, Klem (1969) found that with jumps in ring widths up to approximately 50 percent due to fertilization, the changes in wood properties were very small; with increase in growth rates of more than 100 percent due to thinning, the changes in wood properties were more

pronounced, but meant in most cases a transition from starvation wood to normal wood. He again concluded that the growth rate can be increased considerably without any substantial reduction in specific gravity.

Variations in ring width do not appear to have a major influence on the durability of wood under normal silvicultural practices (Scheffer, 1957; Da Costa et al, 1961).

Crown Development and Wood Quality

The relation between growing space and branch development is a major factor in the effect of growing space on wood quality. The disappointing quality of the sawn timber obtained from some young plantations has been due largely to knottiness associated with the much wider spacings of the plantations compared with that of the natural stands from which wood of the same species had previously been obtained. However, other factors, such as the greater proportion of corewood in the logs from such plantations, also play a part. Klem (1952) in a study of spruce grown at spacings varying from 1.25 x 1.4 meters to 3.5 x 3.5 meters found that the timber quality, as shown by the grade yield of the sawn boards, decreased with increased spacing and that all the reductions in grade were due to knots. Also, Haveraaen (1960) found that in Pinus sylvestris and Picea abies the quality of the wood, as determined by the prevalence and size of knots and ring width, decreased with increasing spacing (Fielding, 1967).

Processes involving cutting out knotting material and edge-and-edge gluing clear material, however, have already been established commercially in the United States (Englerth and Wollin, 1962).

Haught (1958) and Zobel and Haught (1962) showed that the size of the branches of Pinus taeda is directly related to the amount of compression wood developed in the trunk at the base of the branches (Fielding, 1967). Compression wood is characterized by relatively high specific gravity, excessive longitudinal shrinkage and, in general, low strength in relation to its specific gravity: it causes trouble in sawing, veneering, seasoning, machining, and finishing. Compression wood is also associated with increased micellar angle and decreased tracheid length. It has a high content of lignin and a low content of cellulose. A large amount of lignin has to be removed from compression wood in the pulping process, and the pulp yield is lower.

In total, there has been a large amount of work done on the effect of the rate of growth and of crown development on the various attributes of timber quality. Both the rate of growth and the crown development are associated with the growing space available to the tree. Hence, they could certainly be identified as part of the effect of the initial growing space. But, the rate of growth and the crown development are also associated with stand age and site quality. The initial growing space may

also influence timber quality independently of its association with the rate of growth and crown development. In short, the effect of the initial growing space on the various attributes of timber quality may have to be determined in conjunction with the effect of stand age and site quality through a multi-dimensional mathematical model.

Miscellaneous Effects of Spacing on Wood Quality

The amount of available growing space may influence wood quality through its effects on the vigour and health of a tree. Harzman (1957) concluded that a bark disease which produced discolouration and bark pockets in poplars was caused basically by insufficient growing space. On the other hand, Anderson (1958) contended that, where conifers are subject to heart rot caused by Fomes annosus, it is advantageous to grow the trees densely when young to reduce the amount of early-wood and to increase the amount of resin in the centre of the trunk.

Low and Taylor (1967) reported that widely spaced Sitka spruce suffered more severely than closely spaced on frosty sites. After forming a complete canopy, 8 x 8 foot spacing showed a marked degree of stem malformation which diminished progressively to the 3 x 3 foot spacing.

An investigation by Cromer and Pawsey (1957) of stem conditions in Pinus radiata disclosed unexpectedly that neither crookedness, butt sweep, nor lean was influenced by spacing. Forking, however, was found to be linearly related to spacing, being less in the closer spacings, though the differences between spacings were small.

In Pinus radiata, which typically produced more than one whorl of branches annually, the result of suppression or partial suppression is not only a reduction of branch size but also a reduction in the number of whorls of branches and an increase in the length of the internodes on the trunk (Fielding, 1960).

Evert (1971) also considered the effect of spacing on tree taper. He found there were few studies done on the relationship between the form factor and spacing, the form factor in spacing studies having almost invariably been taken from standard volume tables, usually involving the dbh and height only (e.g. Brown and Gevorkiantz, 1934; Hicock and Kienholz, 1938; Olson et al, 1949) and sometimes the dbh, height and form quotient (e.g. Anon., 1948).

In these standard volume tables, the breast-high form-factor of the total stem volume is usually a function of both the dbh and height, and in case of form-class volume tables, also of the form quotient.

There is the possibility, of course, that the relationship between the form factor and spacing is purely a reflection of the effect of spacing on dbh and therefore there is no need to study the residual effect

of spacing on form factor. However, the few studies done on the relationship between the form factor and spacing indicate otherwise.

Kjersgard (1964) has shown that in about a 20-year-old Norway spruce stand with initial spacings of from 0.5 x 0.5 to 2.5 x 2.5 meters, the form factor of felled, and as far as possible typical trees, decreased considerably with increased spacing.

The effect of spacing on the form factor of the mean tree was also investigated by Marsh (1957) in stands of Pinus patula at densities of from 50 to 1200 stems per acre. His results were similar to those of Kjersgard.

Stiell (1964) found that greater average form-class, the ratio of the d.i.b. at half the tree height above breast height to d.i.b. at breast height, was associated with closer spacing, although form class showed no significant relationship to dbh. The spacings involved were 7 x 7, 10 x 10, and 12 x 12 feet in a 20-year-old red pine stand.

One cannot escape the conclusion that the breast high form-factor of the total stem volume may decrease considerably with increased spacing regardless of tree size.

Spacing and Height Growth

Some spacing experiments show increased height growth after spacing. Some do not. Evert (1971) cites three reviews of spacing and other studies which have apparently conflicting results. He draws the conclusion that in very dense young plantations on poor to medium sites, height growth is likely to increase with increased spacing. On good sites there appears to be no practical change in height growth as spacing increases.

The definition of mean height can affect the perceived effect of spacing on height growth. Evert (1971) gives an example from stands of Picea glauca (white spruce) and Pinus resinosa (red pine). First, average height was calculated as the average of the tallest 100 trees per acre. Next, the calculation was made for the tallest ten percent of trees. The difference between these quantities was calculated for spacings of 200 to 1400 trees per hectare. At 200 trees per hectare the 100 tallest trees were higher than the tallest ten percent. At 1000 trees per hectare the two quantities were, of course, equal. At higher densities the top ten percent was taller than the top 100. One should be cautious when generalizing about the effect of spacing on height growth.

Spacing and Mean Diameter

Spacing increases tree diameter growth. In practically all spacing experiments, for all species, mean diameter of the stand increases as growing space increases.

Spacing and Basal Area Production

In almost all spacing experiments, basal area production in young stands has decreased as initial spacing decreases. Table 1 from Nawitka Resource Consultants (1987) shows an example for Douglas-fir in the Shawnigan Lake experiment.

Table 1. Shawnigan Lake Experiment 1971 Series Data Basal Area Increment

	Control		Light Thinning		Heavy Thinning	
Age	Stem # 1 ha	Increment 1 ha	Stem # 1 ha	Increment 1 ha	Stem # 1 ha	Increment 1 ha
24	4704		1926		889	
		5.08		3.66		2.93
27	4667		1914		889	
		4.51		3.76		3.12
30	4654		1901		889	
		4.42		3.62		3.08
33	4605		1901		889	
		4.86		4.08		3.54
36	4506		1901		889	

Spacing and Volume Production

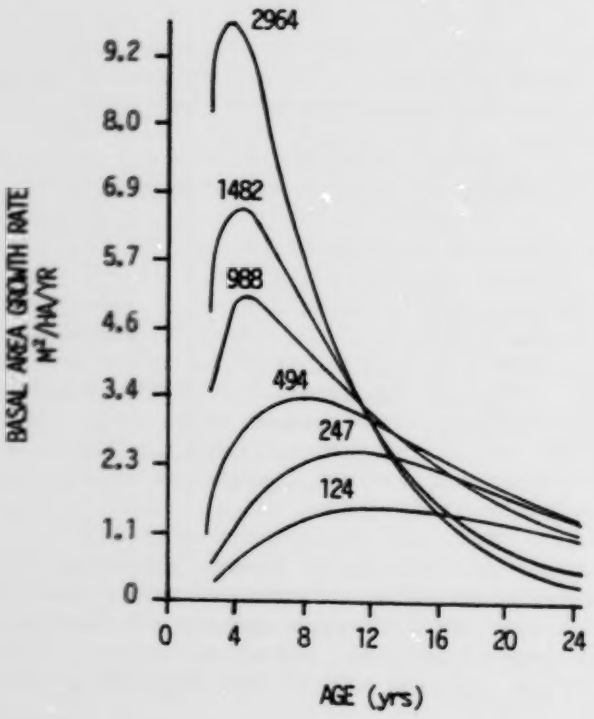
As with basal area, total volume production in young stands decreases with initial spacing. Merchantable volume sometimes decreases, sometimes increases.

As stands age, both total live basal area and total live volume converge to similar values, from a wide range of initial spacings. This final value, or constant final yield, is discussed by Nawitka Resource Consultants (1987). Pienaar and Turnbull (1973) produced some important results on the pattern of convergence to the same final yield. Figure 1 shows the graph of current annual increment (CAI) (total stand) against

age for six different starting densities. For each density the CAI rises to a maximum and then decreases. Figure 1 forces the following conclusions for total stand growth:

- the maximum CAI is highest at the highest starting density and lowest at the starting density; maximum CAI decreases progressively as the starting density decreases
- the maximum CAI occurs at the youngest age for the highest density and at the oldest age for the lowest density; maximum CAI occurs at progressively older ages as the starting density decreases
- after the maximum CAI has been reached, it declines much faster for higher starting densities and eventually drops below the CAI for the lower densities.

Figure 1. Slash Pine Live Basal Area Growth Rates in Relation to Age for Different Initial Densities (stems/ha)
Adapted from Pienaar and Turnbull (1973)



For the total stand, Figure 1 shows that low density stands take longer to reach the final yield but grow more steadily than high density stands. High density stands grow at a fast early rate which peaks at a younger age that low density stands and then falls off rapidly.

As stands age and individual trees get bigger, the stand fully uses site productivity. In spaced stands the same volume production is spread over fewer larger trees than in dense stands. Nawitka Resource Consultants (1987) discuss the differences between total volume and merchantable volume response. Thinning often increases the merchantable volume yield. This is particulary true in thinned matured stands of Lodgepole Pine. (Johnstone (1984), Cole and Edminster (1984)).

FERTILIZATION

Nawitka Resource Consultants (1987) give the following summary of how fertilizer affects stand growth.

There are 14 essential nutrient elements that plants obtain from the soil (Brady 1974). Eight of these elements are used by plants as micronutrients. Of the remaining six, calcium, magnesium and sulphur are applied in special agricultural circumstances. The remaining three, nitrogen, phosphorus and potassium, are so commonly applied in agriculture that they are referred to as the fertilizer elements.

In forestry, fertilization usually means the application of nitrogen in the form of synthetic urea. The percentage of nitrogen un urea is about 42-45%. In the soil, urea undergoes hydrolysis, producing ammonium carbonate as follows:

$$CO(NH_2)_2 + 2H_2O \longrightarrow (NH_4)_2CO_3$$

The immediate effect of this fertilizer on the soil is to make it more alkaline, although its later influence is to lower soil pH. The ammonium carbonate produced is ideal for rapid nitrification, especially if exchangeable bases are present in adequate amounts. Urea ultimately presents both ammonium and nitrate ions for plant absorbtion. Its one serious objection, high deliquescence, has been largely overcome by coating the particles with dry powders and using slower release urea formaldehyde complexes. Nitrogen fertilizer increases leaf production in agricultural and forest crops which is followed by increased total biomass production.

After surface application, nitrogen moves vertically downwards through the soil horizon. The response to fertilization of forests is variable. This is because different species, different soil types with different ion-exchange capacities, and climatic conditions during or just after the application, can all affect the response to fertilization.

For forest crops a single application of fertilizer raises nutrient levels for a small fraction of the growth cycle or rotation. Only about 15 - 20% of the added nitrogen is taken up by the forest stand and associated grown cover (Otchere-Boateng 1979). Dangerfield and Brix (1979) discuss the effect of urea fertilizer on available soil nitrogen. Maximum ammonium cation concentrations occur in the first few months after fertilization. Brix (1983) shows the growth response to fertilization first occurs in the season following fertilization. Both the mass of foliage, through more buds and larger needles, and the photosynthesis per unit area of foliage increase in the first year after fertilization. In successive years the added nitrogen in the crown is diluted by transfer to new needles. The growth response due to increased photosynthetic efficiency is high in the first three to four years, but decreased to zero by year four or five. The addition of new foliar mass follows the same pattern as the increase in photosynthetic efficiency.

The pattern of foliar response implies a wood growth response period of about 12 years for a single fertilization of Douglas fir. This is made up on a one year lag after fertilization plus five years of increased needle production and photosynthetic efficiency, plus a six year life span for the needles, (1 + 5 + 6 = 12). Two data sets from research experiments support a 12 year response period for Douglas fir. The first is given by Peterson (1985) in reviewing the volume response of fertilized Douglas fir stands in Washington. The second data set is provided by Barclay and Brix (1985) for the Shawnigan Lake experiment.

In British Columbia, fertilization is applied to coastal Douglas-fir and interior Lodgepole pine. Douglas fir stand have been fertilized for some time, but fertilizing Lodgepole pine began in 1980. Very recently Brockley (1989) reported on three-year responses to fertilization in Lodgepole pine. Data from Miller et al (1979) suggest that the total volume responses from fertilizing Douglas-fir at a rate of 200 kg per ha are 22 m^3/ha, 29 m^3/ha and 41 m^3/ha on good, medium and poor sites respectively.

SPACING AND FERTILIZATION

Fertilization increases total and merchantable stand volume and reduces the age at which stems become merchantable. In spaced stands which have also been fertilized, the early combined treatment effects on merchantable stand volume may exceed the sum of the fertilization effect and the spacing effect when applied as single treatments. Later on this 'synergistic effect' would be expected to diminish. Once a stand age is reached where all stems in a spaced stand and all stems in a fertilized stand are merchantable, the combined treatment effect on merchantable volume should equal the sum of the separate effects.

GROWTH RESPONSE CONCLUSIONS

In fields of biology besides forestry the development of coherent and flexible theories of growth and yield has been a major objective. A comprehensive general theory of forest growth has yet to be developed. Even so, it is possible to construct a framework of principles from known forest growth and yield theory. A recent example of this is given by Nawitka Resource Consultants (1987). They linked mensurational and physiological principles of forest growth with response to intensive treatments. Growth of the total stand, merchantable stand and the effects of operational conditions were discussed. The following conclusions were presented.

For the total stand (all live trees, however small) in even-aged stand, the following conclusions apply:

(1) A given site has a fixed productive capacity because it provides just so much soil moisture, soil nutrients, carbon dioxide and sunlight for plant growth.

(2) The productive capacity of a site can only be raised by supplying more soil moisture, soil nutrients, carbon dioxide and sunlight wherever one or more of these factors is limiting plant growth.

(3) Stand tending treatments involving thinning or spacing cannot by themselves increase the total productive capacity (final yield) of a site.

(4) The initial density of a stand affects its subsequent growth pattern. In particular the peak growth rate CAI is higher in dense stands decreasing progressively as initial density decreases. The peak CAI occurs sooner for high density stands and occurs at progressively older ages as initial density decreases. After the peak CAI has been reached, it declines much faster for higher initial densities and eventually drops below the CAI for lower densities.

(5) Spacing or thinning treatments affect the subsequent growth pattern of a stand in a similar way to changing the initial density. Spacing a high density stand shifts the CAI curve from a high initial density growth pattern to the growth pattern for a low initial density stand.

(6) The direct effect of a single fertilizer treatment is temporary. In coastal Douglas fir, it lasts about 12 years. Because fertilization changes stand structure, the subsequent development of a fertilized stand will be different from an untreated stand.

For the merchantable part of even aged stands, the following conclusions apply:

(1) As for the total stand a given site has a fixed productive capacity, or maximum final yield.

(2) In all stands, nearly all live stems eventually become merchantable. Nevertheless, merchantable volume never equals total volume because of the wood lost in the stumps and tops.

(3) Stand tending treatments increase the proportion of total stand volume which is merchantable, and reduce the age at which all live stems become merchantable.

(4) Unlike total stand volume, spacing treatments can produce an equal or greater merchantable stand volume than an untreated stand, over a considerable part of the rotation. Eventually, the merchantable volume in the spaced and unspaced stands will converge.

(5) Spacing and fertilization treatments reduce the age at which a stand reaches harvestable size.

(6) In the first years after treatment, it is reasonable to expect the effects on merchantable volume of spacing and fertilization combined to exceed the sum of the separate treatment effects. Later this "synergistic" effect should diminish.

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METHODS

The method chosen to estimate responses to treatment was to use the forest stand simulation model, PROGNOSIS. The behaviour of this model generally corresponds to the framework of accepted growth and yield principles outlined above. PROGNOSIS was developed by the U.S. Forest Service (USFS) at the Forestry Sciences Laboratory, Moscow, Idaho.

THE PROGNOSIS MODEL

Silviculturalists planning the management of Northern Rocky Mountain forests have found the PROGNOSIS model for stand development (Stage 1973) to be a useful tool for comparing different stand treatments. Since its introduction, the model has grown and evolved. Regional variants of the model have been calibrated for eastern Montana and central Idaho.

When production of timber is an objective, growth predictions are the basis for estimating the yield of products that would be removed from the stand at varying times in the future. To be most useful, yield forecasts comparing alternative silvicultural regimes should accurately represent the differences in expected yield among the alternatives. Accuracy of yield estimates for a single alternative is less critical than accurate comparison of differences between alternatives. Successful projections require a close co-ordination between inventory methods and the process for developing forecasts of subsequent yields. These circumstances led to the following criteria for constructing the PROGNOSIS model.

(1) Use existing inventory methods as sources of input and produce estimates of initial conditions of volume and growth that are consistent with estimates calculated with standard inventory compilation techniques.

(2) The model should be applicable in all timber types and stand conditions encountered in the inventory.

(3) Growth predictions must be consistent with growth rates measured in the inventory.

(4) Stands are defined as the basic unit of treatment. Growth projections are dependent on interactions between trees within stands.

(5) The model must be able to incorporate the growth of the current inventory into projections.

Silviculture treatments that can be evaluated include stocking control, regeneration methods, site preparation, and fertilization.

When periodic increment data are provided to the model, the imbedded increment models will be adjusted to reflect local conditions. Both the diameter increment and small-tree height increment models may be calibrated to real data. When calibration is completed, stand density statistics are updated to correspond to the actual initial conditions. In fact, there are four ways in which the model output can be adjusted to fit data from real stands.

First, there is the built in scaling procedure just described. Second, random effects can be represented by the model. Third, scalars for adjusting all increments can be input to the model. Fourth, the behaviour of the mortality models can be targeted to particular species and to specific mortality patterns.

The range of the PROGNOSIS model can be effectively extended by judicious use of scaling factors and multipliers which are based on real increment and yield data.

PROGNOSIS is designed to provide several thinning and spacing options. These are:

- prescription thinning
- diameter limit thinning
- thin from below to a trees/ha target
- thin from above to a trees/ha target
- thin from below to a basal area/ha target
- thin from above to a basal area/ha target

The diameter limit thinning option can be used to remove segments of the dbh distribution without regard to species or to tree value class. This option allows simulation of treatments such as cleaning, overwood removal, and conifer release.

In thinning, the user can combine options to implement special thinning strategies and, in addition, can control the species composition of the stand to favour desirable trees.

The response to fertilization can be simulated with PROGNOSIS by taking advantage of the height and basal area growth multipliers. First, the direct effect of fertilization is assumed to last 12 years. Second, the direct effect is assumed to rise and then fall over the 12 year period, with a peak response occurring at five years after fertilization. The basal area and height response can be expressed as a triangle whose base area increments can be introduced by using 12 height and basal area growth multipliers with a cycle of 1 year each. In this way, fertilization will be expressed as a temporary 12 year effect on height and basal area increment. A simpler alternative is to use an average increased rate of basal area growth for the 12 year period. The stand dynamics resulting

from these increments will be automatically simulated by PROGNOSIS. After 12 years the height and basal area increment functions will return to the same values as the untreated stand. However, stem numbers and diameter and standing volume in the fertilized stand will be different from the untreated stand. This method can be applied with or without concurrent thinning treatments.

Brushing and weeding treatments can simulated by using the height growth and mortality input multipliers to describe the affect of the treatment on a young stand suffering heavy competition. Another method is to introduce a competing species showing shrub-like growth.

The model PROGNOSIS provides conventional site index as an output but does not use it as an input. Site is defined as a combination of forest type, habitat, aspect, slope and elevation. This can be replaced by the conventional definition of site index when model output for a given site index is obtained using the height growth multiplier to produce a stand whose average dominant and co-dominant height at the reference age (e.g. 50 years breast height age) equals the required site index.

The habitat types used in PROGNOSIS and their links to B.C. biogeoclimatic zones are described in the next section.

HABITAT TYPES AND B.C. BIOGEOCLIMATIC ZONES

In B.C. and Montana, two different ecological classification systems are used. Both systems have the same philosophical background. The B.C. system is based on work by Krajina and the Montana system is based on work by Daubenmire. In Montana, the CLIMAX SERIES idea is equivalent to the BIOGEOCLIMATIC ZONE idea in B.C. In Montana several HABITAT TYPES are found within each CLIMAX SERIES. In B.C. several ECOSYSTEM ASSOCIATIONS are found within each BIOGEOCLIMATIC ZONE. The idea of the habitat type is equivalent to the idea of the ecosystem association.

The set of ecosystems in Montana is not identical with, but does overlap, the set of ecosystems in B.C. A given climax series in Montana contains some habitat types identical to those found in B.C. and others not occurring in B.C. Similarly a B.C. biogeoclimatic zone may contain ecosystem associations not exactly duplicated or not present in Montana. Table 2 shows those climax series which share equivalent ecosystem associations (habitat types) with B.C. biogeoclimatic zones.

Table 2. Climax Series and Equivalent Biogeoclimatic Zone

Montana Climax Series	Equivalent B.C. Biogeoclimatic Zone
Pinus ponderosa	Ponderosa Pine
Pseudotsuga menziesii	Interior Douglas-fir
Picea	Montane Spruce
Abies grandis Thuja plicata Tsuga Heterophylla	Interior Cedar-Hemlock
Abies lasiocarpa	Engelmann Spruce-Subalpine fir

Table 3 shows the habitat types included in PROGNOSIS and to which B.C. biogeoclimatic zone they belong.

Table 3. Prognosis Habitat Types Within Each B.C. Biogeoclimatic Zone

Habitat Code	Habitat Type Name	Biogeoclimatic Zone
130	Pinus ponderosa/Agropyron spicatum	Ponderosa Pine
170	Pinus ponderosa/Symphoricarpos albus	
250	Pseudotsuga menziesii/Vaccinium caespitosum	Interior Douglas-fir
260	Pseudotsuga menziesii/Physocarpus malvaceous	
280	Pseudotsuga menziesii/Vaccinium globulare	
290	Pseudotsuga menziesii/Linnaea borealis	
310	Pseudotsuga menziesii/Symphoricarpos albus	
320	Pseudotsuga menziesii/Calamagrostis rubescens	
330	Pseudotsuga menziesii/Carex geyeri	
420	Picea/Clintonia uniflora	Montane Spruce
470	Picea/Linnaea borealis	
510	Abies grandis/Xerophyllum tenax	Interior Cedar-Hemlock
520	Abies grandis/Clintonia uniflora	
530	Thuja plicata/Clintonia uniflora	
540	Thuja plicata/Athyrium filix-femina	
550	Thuja plicata/Oplopanax horridum	
570	Tsuga heterophylla/Clintonia uniflora	
610	Abies lasiocarpa/Oplopanax horridum	Engelmann spruce-subalpine fir
620	Abies lasiocarpa/Clintonia uniflora	
640	Abies lasiocarpa/Vaccinium caespitosum	
660	Abies lasiocarpa/Linnaea borealix	
670	Abies lasiocarpa/Menziesia ferruginea	
680	Tsuga mertensiana/Menziesia ferruginea	
690	Abies lasiocarpa/Xerophyllum tenax	
710	Tsuga mertensiana/Xerophyllum tenax	
720	Abies lasiocarpa/Vaccinium globulare	
730	Abies lasiocarpa/Vaccinium scoparium	
830	Abies lasiocarpa/Luzula hitchcockii	
850	Pinus albicaulis/Abies lasiocarpa	
999	OTHER	OTHER

PROGNOSIS does not contain any habitat types from the Coastal Douglas-fir and Coastal Western Hemlock Biogeoclimatic zones. It is possible that some habitat types from the Montana Spruce Zone approximate conditions in the Sub-Boreal Pine-Spruce Zone and Sub-Boreal Spruce Zone. Some habitat types from the Engelmann Spruce-Subalpine Fir Zone may approximate conditions in the Boreal Spruce Zone.

In PROGNOSIS itself, model coefficients are not unique to a single habitat type but to groups to habitat types.

USING PROGNOSIS

The simulation model PROGNOSIS was used to estimate expected response estimates for several silvicultural treatments and for equivalent untreated forest stands. The result of this process was the set of yield tables shown in appendix 1. The silviculture practices simulated were:

- planting of backlog areas
- brushing and weeding
- conifer release
- juvenile spacing
- fertilization
- juvenile spacing combined with fertilization

Responses were estimated for:

- coastal Douglas-fir
- coastal western hemlock
- coastal mixtures of western hemlock and amabalis fir
- interior spruce
- interior Lodgepole pine
- interior west best Douglas-fir

A different subset of silviculture practices was applied to each species. Table 4 shows the matching of treatment with species. Responses were estimated for good and medium sites.

Table 4: Silvicultural Treatments Applied to Each Species

	Treatment						
	Plnt	**B&W**	**Con.Rel**	**Spac**	**Fert**	**Spac/Fert**	**None**
Coast D-fir	X	X	X	X	X	X	X
Coast Hem.	X			X			X
Coast Hembal				X			X
Int. Spruce	X		X	X			X
Int. Lodgepole	X			X	X	X	X
Wet belt D-Fir	X			X		X	X

The post establishment treatments used were applied to plantations and natural stands, except for Lodgepole pine, where fertilization without spacing was applied to plantations only and fertilization with spacing was applied to natural stands only.

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RESPONSE ESTIMATES FOR INTERIOR SPECIES

PROGNOSIS is calibrated for ecosystem associations in five interior biogeoclimatic zones. The model was further adapted to B.C. by changing the internal mapping of habitat types and locations. PROGNOSIS groups habitat types and locations into classes. Co-efficients of submodels are specific to a group of habitat types or a group of locations. For each tree species, the co-efficients of each habitat group were mapped to the most appropriate biogeoclimatic zone. For location specific co-efficients, for each species, the co-efficients from the most appropriate Montana location class were mapped to the Interior B.C. as a single location. The re-mapping of PROGNOSIS co-efficients was done for the small and large tree diameter increment model, the small and large tree height increment models, and the small and large tree crown change models. When running PROGNOSIS for the interior the height multiplier keywords were used to ensure that stand top height at reference age equalled that of the site index curves used in B.C. For the interior species model co-efficients representing the biogeoclimatic zones in table 5 were used in PROGNOSIS.

Table 5. Biogeoclimatic zones used for Growth Estimates of Interior Species

Species	Biogeoclimatic Zone
Spruce	Montane Spruce
Lodgepole Pine	Montane Spruce
Wet-Belt Douglas-fir	Interior Cedar-Hemlock

TREATMENT DEFINITIONS

For the interior species, the treatments previously shown in table 4 were defined as follows:

Natural Stands

Natural stand starting densities were 2,500 stems per hectare for spruce and wet-belt Douglas-fir, and 8,260 for Lodgepole pine.

Planting

Planting densities used were 1,100 trees per hectare for spruce, and wet-belt Douglas-fir, and 1,600 for Lodgepole pine.

Brushing and Weeding

Removal of competing vegetation which does not form a continuous canopy above the commercial trees.

Conifer Release

Removal of competing vegetation which forms a dense canopy over-topping the commercial trees.

Spacing

Reduction of stems per hectare to 650 for spruce and wet-belt Douglas-fir, and 1,600 for Lodgepole pine. Spacing was applied at 26 years of age for good site spruce, good and medium Lodgepole pine and good site wet-belt Douglas-fir. Medium site spruce and Douglas-fir was spaced at 31 years.

Fertilization

Lodgepole pine was the only interior species where fertilization response were estimated. Total volume per hectare direct response over a 12 year period was assumed to be 29 m^3 for good sites, and 34 m^3 for medium sites. Fertilization was applied at 26 years.

RUNNING PROGNOSIS

Starting with a representative young stand for each species, PROGNOSIS was run for each species, site and treatment combination. The results, modified to represent operational conditions, are shown in Appendix 1.

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RESPONSE ESTIMATES FOR COASTAL SPECIES

PROGNOSIS is not calibrated for B.C. coastal biogeoclimatic zones. A four step procedure was used to adjust PROGNOSIS for coastal B.C. First, sample growth plots were obtained from the MOF. Second, software was written to convert the MOF sample plot data into sample tree files required for input to PROGNOSIS. Third, the growth multipliers in PROGNOSIS were adjusted so that the model predictions were close to the observed re-measurements of sample plots. Fourth, the model was run using young stands as initial conditions and height growth multipliers were used to produce stand height growth which followed the height curves used for coastal Douglas-fir and western hemlock.

For this project the available sample plot data set was much smaller than expected and the range of sites was restricted. For useable re-measured plots, the initial measurement age varied between about 55 to 110 years. In adjusting PROGNOSIS to fit these plots, measured diameter increments were used. The model uses this information to calibrate its diameter growth increment sub-model. The basal area growth multipliers in PROGNOSIS were used to adjust the volume predictions to the observed plot data. When young stands were used as initial conditions for yield tables, diameter increments were not available. To compensate for this the height growth and basal area growth multipliers obtained from older permanent sample plot data had to be revised.

For coastal hemlock/amabalis fir mixtures, Abies grandis was substituted for Abies amabalis in PROGNOSIS model runs.

TREATMENT DEFINITIONS

For the coastal species, the treatments shown earlier in table 4 were defined as follows:

Natural Stands

Starting densities for natural stands were 2,800 stems per hectare for Douglas-fir, and 3,100 for hemlock and hemlock/balsam mixtures.

Planting

Planting densities were 1,100 stems per hectare for Douglas-fir and hemlock.

Brushing and Weeding and Conifer Release

As for interior stands.

Spacing

Reduction of stems per hectare to 650 at 26 years for all species and sites.

Fertilization

Douglas-fir was the only coastal species where fertilization responses were estimated. Total volume per hectare direct responses over a 12 year period were assumed to be 22 m^3/ha and 29 m^3/ha for good and medium sites, respectively.

RUNNING PROGNOSIS

Starting with a representative young stand for each species, PROGNOSIS was run for each species, site and treatment combinations. The results, modified to represent operational conditions are shown in Appendix 1.

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OPERATIONAL CONDITIONS

The responses to intensive treatments which are captured in the merchantable part of the stand are different from total stand responses. Similarly, responses in operational conditions are different from those found in research conditions. Mitchell and Cameron (1985) suggest that research plots produce yields in excess of what can be achieved operationally because microsite, irregular spacing, environmental conditions and other factors are not as carefully controlled in the operational environment as they are in research installations. Research plots are often treated, altered or abandoned if damaged by pests, weather, or other agents. Mitchell and Cameron (1985) identify three reasons for differences between potential (research plot) yields and operational yields. There are, site occupancy, chronic losses, and productive potential.

Site occupancy refers to the effect of rock outcrops, small marshes, and other openings that create unproductive areas. Understocking associated with low regeneration density, clumping, brush competition, and mortality from insects, diseases and other pests has a similar impact. Overstocked stands. on the other hand, can carry high volumes for short periods, but are unstable and prone to snow and ice damage.

Chronic losses caused by insects, pests and diseases can reduce volume growth without killing trees.

Productive potential means that some areas may be relatively more productive that others, relative to top height. This concept is incorporated into the British Forest Management Tables (Bradley et al, 1971) as "Production Classes." The authors state that "factors which influence Production Class tend to be macro-climatical rather than specific to individual stands." Genetic makeup could also contribute to differences in the productive potential.

For coastal Douglas-fir, Mitchell and Cameron estimate the difference between potential and actual total yield to be 20% in stands 40 meters in height. This difference can be minimized by forestry practices like site preparation, planting, brushing and weeding, spacing and thinning, fertilization and pest management.

The biggest difference between actual and potential total yields will be found in naturally regenerated second growth stands. The smallest difference will be found in intensively managed plantations. In this sense, in operation conditions, forestry practices result in a yield "gain." For example, if forestry practices result in a yield equal to 90% of potential versus 80% in natural stands, then a 12.5% gain (10/80) has been achieved.

To express the difference between operational and potential yields, the volumes and stems per hectare obtained from PROGNOSIS runs were reduced by the factors shown in Table 6.

Table 6. Operational Adjustment Factors

	Natural and Natural Fertilized	Other Treatments
Coast		
Douglas-fir	0.85	0.9
Hemlock	0.85	0.9
Hemlock/Douglas	0.85	0.9
Interior		
Spruce	0.8	0.9
Lodgepole Pine	0.8	0.9
Wet-belt Douglas-fir	0.8	0.9

RESPONSES

The biological responses from PROGNOSIS were expressed as the set of yield tables presented in Appendix 1. Merchantable volume includes all trees whose diameter at breast height (DBH) is 17.5 cm or greater. Merchantable volume in a single tree is that above a 30 cm stump up to a 10 cm top.

Operational adjustment factors were applied to the yield tables to reflect the difference between potential yield and those achieved in operational conditions. Reductions for decay waste and breakage were also included.

The results from PROGNOSIS for merchantable volume and diameter are good. After spacing, the total stand volume recovers over a period which varies for species and site. With one exception the recovery period is 40 years or greater. The most frequent recovery period across all species is 60 years. Long recovery periods after heavy spacing are also estimated by the B.C. Ministry of Forests. In good site natural coastal Douglas-fir PROGNOSIS estimates a 20 year recovery period. This inconsistency may be caused by changes in the live crown ratio in the PROGNOSIS model after spacing. Apart from the short recovery period, the volume and diameters for spaced natural good site coastal Douglas-fir are realistic. In general PROGNOSIS estimates a shorter recovery period for heavily spaced natural stands than for spaced plantations.

As described earlier in the report, the effect of fertilization is a transient increase in site productivity. Theoretically, the 12-year volume gain from fertilization would simply be added to the volume of the untreated stand. In practice, the long term volume response to a single fertilization is unknown. Beyond 30 or 40 years after fertilization, stand dynamics can mask the treatment effect. It is equally possible to rationalize an increasing long term effect of fertilization or a decreasing long term effect. PROGNOSIS is consistent in estimating the volume effects of fertilizer for about 40 years after treatment.

In the longer term the PROGNOSIS volume response estimates from fertilization are not consistent even after smoothing. For example, in coastal Douglas-fir good site plantations the response to fertilizer increases over the long term. In medium site natural coastal Douglas-fir, beyond 70 years stand age, the estimated fertilizer response decreases. Since little is known about the long term fertilizer response in real stands it seems inadvisable to use the long term responses (more than 40 years after treatment) from PROGNOSIS. For the long term volume response it may be best simply to add the short term response from fertilizer to the volume of the equivalent untreated stand.

The yield tables represent good and medium sites. The site index definitions used for good and medium are equivalent to the Ministry of Forests definitions. Table 7 shown site index for breast height age 50 years (BHSI).

Table 7. Site Index Definitions

Species	GOOD		MEDIUM	
	BHSI	Yrs to BH	BHSI	Yrs to BH
Coastal Douglas-fir	35	8	27	9
Coastal Hemlock	30	5	22	7
Interior Spruce	23	13	16	15
Interior Lodgepole Pine	25	10	18	11
Interior Wet-belt Douglas-fir	22	9	18	10

Hemlock site index was used to define good and medium Hemlock/Balsam stands. The treatments simulated vary for each species. The basic set common to all species was natural stand, plantation, spaced natural stand, spaced plantation. Coastal Douglas-fir also included natural stand and plantation spaced and fertilized; stands suffering from brush or weed competition, stands overtopped by deciduous trees and stands treated for conifer release.

Interior Spruce included competition from brush and weeds; overtopped stands and stands treated for conifer release. Interior Lodgepole Pine included spaced and fertilized natural stands and fertilized plantations.

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APPENDIX 1

TABLE OF CONTENTS

	Page
FOREWORD	34
COASTAL DOUGLAS-FIR	37
COASTAL WESTERN HEMLOCK	49
COASTAL HEMLOCK/BALSAM	53
INTERIOR SPRUCE	55
INTERIOR LODGEPOLE PINE	61
INTERIOR WET-BELT DOUGLAS-FIR	67

FOREWORD

These yield tables are part of a FRDA contract "Analysis of Biological Response From Silviculture Treatments Under FRDA."

All yield tables were developed using the computer model "PROGNOSIS." Merchantable volume includes all trees whose diameter at breast height (DBH) is 17.5 cm or greater. Merchantable volume in a single tree is that above a 30 cm stump up to a 10 cm top.

Operational adjustment factors have been applied to the yield tables to reflect the difference between potential yields and those achieved in operational conditions. Reductions for decay waste and breakage have also been included.

Table 1 below shows the total reduction factors applied to volumes and stem numbers.

Table 1. Operational Adjustment Factors

	Natural and Natural Fertilized	Other Treatments
Coast		
Douglas-fir	0.85	0.9
Hemlock	0.85	0.9
Hemlock/Balsam	0.85	0.9
Interior		
Spruce	0.8	0.9
Lodgepole Pine	0.8	0.9
Wet-belt Douglas-fir	0.8	0.9

The results from PROGNOSIS for merchantable volume and diameter are good. After spacing, the total stand volume recovers over a period which varies for species and site. With one exception the recovery period is 40 years or greater. The most frequent recovery period across all species is 60 years. Long recovery periods after heavy spacing are also estimated by the B.C. Ministry of Forests. In good site natural coastal Douglas-fir PROGNOSIS estimates a 20 year recovery period. This inconsistency may be caused by changes in the live crown ratio in the PROGNOSIS model after

spacing. Apart from the short recovery period, the volume and diameters for spaced natural good site coastal Douglas-fir are realistic. In general PROGNOSIS estimates a shorter recovery period for heavily spaced natural stands than for spaced plantations.

As described earlier in the report, the effect of fertilization is a transient increase in site productivity. Theoretically, the 12-year volume gain from fertilization would simply be added to the volume of the untreated stand. In practice, the long term volume response to a single fertilization is unknown. Beyond 30 or 40 years after fertilization stand dynamics can mask the treatment effect. It is equally possible to rationalize an increasing long term effect of fertilization or a decreasing long term effect. PROGNOSIS is consistent in estimating the volume effects of fertilizer for about 40 years after treatment.

In the longer term the PROGNOSIS volume response estimates from fertilization are not consistent even after smoothing. For example, in coastal Douglas-fir good site plantations the response to fertilizer increases over the long term. In medium site natural coastal Douglas-fir, beyond 70 years stand age, the estimated fertilizer response decreases. Since little is known about the long term fertilizer response in real stands it seems inadvisable to use the long term responses (more than 40 years after treatment) from PROGNOSIS. For the long term volume response it may be best simply to add the short term response from fertilizer to the volume of the equivalent untreated stand.

The yield tables represent good and medium sites. The site index definitions used for good and medium are equivalent to the Ministry of Forests definitions. Table 2 shows site index for breast height age 50 years (BHSI).

Table 2. Site Index Definitions

Species	GOOD		MEDIUM	
	BHSI	Yrs to BH	BHSI	Yrs to BH
Coastal Douglas-fir	35	8	27	9
Coastal Hemlock	30	5	22	7
Interior Spruce	23	13	16	15
Interior Lodgepole Pine	25	10	18	11
Interior Wet-Belt Douglas-fir	22	9	18	10

Hemlock site index was used to define good and medium Hemlock/Balsam stands. The treatments simulated vary for each species. The basic set common to all species is natural stand, plantation, spaced natural stand,

spaced plantation. Coastal Douglas-fir also includes natural stand and plantation spaced and fertilized; stands suffering from brush or weed competition, stands overtopped by deciduous trees and stands treated for conifer release. Interior Spruce includes competition from brush and weeds; overtopped stands and stands treated for conifer release. Interior Lodgepole Pine includes spaced and fertilized natural stands and fertilized plantations.

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OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	2385	11	0	5	4	0.0
20	2217	41	3	8	8	0.1
30	1978	169	84	15	17	2.8
40	1455	306	245	20	25	6.1
50	1056	429	392	25	31	7.8
60	783	565	534	30	36	8.9
70	632	669	647	35	40	9.2
80	514	781	761	39	44	9.5
90	445	851	832	43	46	9.2
100	391	912	893	46	48	8.9
110	342	977	959	50	49	8.7
120	309	1029	1010	53	50	8.4
130	275	1085	1067	56	52	8.2
140	250	1124	1106	59	52	7.9

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	2385	11	0	5	4	0.0
20	2217	41	3	8	8	0.1
30	567	102	70	20	17	2.3
40	551	284	269	28	27	6.7
50	516	478	463	34	34	9.3
60	471	644	627	38	39	10.5
70	420	804	786	43	45	11.2
80	380	899	881	46	46	11.0
90	342	985	967	50	48	10.7
100	309	1051	1033	53	50	10.3
110	280	1114	1095	56	52	10.0
120	256	1164	1145	59	53	9.5
130	233	1210	1192	62	54	9.2
140	213	1246	1228	65	55	8.8

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, NATURAL, FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	2385	11	0	5	4	0.0
20	2217	41	3	8	8	0.1
30	2087	209	132	16	18	4.4
40	1476	351	299	21	25	7.5
50	1069	477	435	26	32	8.7
60	796	613	584	31	37	9.7
70	636	721	696	36	40	9.9
80	536	811	789	40	42	9.9
90	456	903	883	44	45	9.8
100	398	981	962	47	47	9.6
110	351	1042	1022	51	48	9.3
120	316	1096	1076	54	50	9.0
130	282	1153	1134	57	51	8.7
140	258	1192	1173	60	52	8.4

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, NATURAL, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	2385	11	0	5	4	0.0
20	2217	41	3	8	8	0.1
30	567	115	97	21	17	3.2
40	547	308	293	29	27	7.3
50	507	503	487	35	33	9.7
60	453	691	674	40	40	11.2
70	420	828	810	43	43	11.6
80	378	949	929	46	45	11.6
90	342	1042	1023	50	47	11.4
100	309	1110	1091	53	49	10.9
110	280	1183	1163	56	50	10.6
120	256	1236	1216	59	52	10.1
130	233	1288	1270	62	53	9.8
140	211	1325	1306	66	54	9.3

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	994	5	0	5	4	0.0
20	980	25	1	10	9	0.0
30	956	129	86	18	16	2.9
40	903	290	260	24	24	6.5
50	803	495	468	30	32	9.4
60	687	653	630	35	37	10.5
70	582	778	757	39	39	10.8
80	502	864	843	42	42	10.5
90	429	949	929	46	45	10.3
100	382	994	974	49	45	9.7
110	338	1044	1024	53	47	9.3
120	298	1094	1075	56	48	9.0
130	265	1136	1117	60	49	8.6
140	240	1163	1144	63	50	8.2

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, PLANTED, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	994	5	0	5	4	0.0
20	980	25	1	10	9	0.0
30	576	106	81	20	17	2.7
40	560	243	227	27	26	5.7
50	522	449	434	33	35	8.7
60	480	576	560	37	38	9.3
70	427	720	703	42	42	10.0
80	373	861	843	47	45	10.5
90	333	942	924	51	46	10.3
100	298	1013	995	54	48	9.9
110	271	1061	1042	57	49	9.5
120	245	1111	1093	61	50	9.1
130	218	1170	1152	65	52	8.9
140	198	1211	1193	68	53	8.5

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, PLANTED, FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	994	5	0	5	4	0.0
20	980	26	1	10	9	0.0
30	958	157	118	20	18	3.9
40	896	347	316	25	27	7.9
50	785	558	533	31	33	10.7
60	687	692	668	35	37	11.1
70	585	813	792	39	41	11.3
80	502	911	890	43	43	11.1
90	442	978	957	46	45	10.6
100	382	1058	1038	50	47	10.4
110	333	1116	1096	53	48	10.0
120	296	1172	1152	57	50	9.6
130	265	1212	1193	60	51	9.2
140	238	1253	1234	64	52	8.8

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, PLANTED, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	994	5	0	5	4	0.0
20	980	26	1	10	9	0.0
30	576	119	93	21	18	3.1
40	558	267	250	27	27	6.3
50	525	473	457	33	35	9.1
60	478	600	584	38	38	9.7
70	429	744	726	42	42	10.4
80	369	918	899	48	47	11.2
90	331	1000	982	51	48	10.9
100	298	1073	1055	55	49	10.5
110	265	1137	1118	58	51	10.2
120	240	1180	1162	62	52	9.7
130	213	1248	1230	66	54	9.5
140	198	1280	1262	69	55	9.0

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, NATURAL/PLANTED, OVERTOPPED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	800	2	0	3	3	0.0
20	738	7	0	5	6	0.0
30	701	12	0	7	9	0.0
40	558	19	2	9	11	0.1
50	432	33	17	12	14	0.3
60	348	50	35	16	16	0.6
70	294	79	58	21	19	0.8
80	235	99	82	25	21	1.0
90	207	153	137	31	27	1.5
100	175	187	168	36	30	1.7
110	151	261	237	44	35	2.2
120	133	287	269	48	37	2.2
130	121	331	310	53	38	2.4
140	114	374	343	56	40	2.5

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, NATURAL/PLANTED, CONIFER RELEASE

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	800	2	0	3	3	0.0
20	664	10	0	8	7	0.0
30	651	54	26	15	14	1.0
40	632	190	162	23	25	4.8
50	600	310	194	28	29	6.9
60	552	458	441	32	33	8.7
70	496	617	600	37	37	10.1
80	441	749	731	41	42	10.8
90	390	852	834	45	45	10.9
100	354	917	899	48	47	10.6
110	307	1022	1004	53	50	10.7
120	277	1074	1056	56	51	10.3
130	246	1134	1116	59	53	10.1
140	223	1171	1153	62	54	9.7

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

GOOD SITE, NATURAL/PLANTED, BRUSHED IN

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
11	343	0	0	1	2	0.0
20	334	3	0	3	5	0.0
30	315	12	1	4	10	0.0
40	311	53	39	8	17	1.0
50	309	172	160	13	30	3.2
60	307	303	275	19	37	4.6
70	296	424	388	25	40	5.5
80	280	631	493	31	44	6.2
90	264	537	583	38	46	6.5
100	241	787	726	45	49	7.3
110	227	868	802	51	50	7.3
120	212	930	861	55	52	7.2
130	197	997	871	59	53	6.7
140	183	1069	922	63	54	6.6

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	2385	11	0	5	4	0.0
20	2312	28	0	7	7	0.0
30	2190	82	19	11	11	0.6
40	1921	169	94	15	16	2.4
50	1615	265	195	19	23	3.9
60	1346	349	292	22	28	4.9
70	1109	419	379	25	30	5.4
80	932	474	441	27	32	5.5
90	792	529	502	30	34	5.6
100	674	587	563	33	36	5.6
110	590	624	602	35	37	5.5
120	512	658	639	38	38	5.3
130	453	690	673	40	40	5.2
140	405	715	698	43	41	5.0

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	2385	11	0	5	4	0.0
20	2312	28	0	7	7	0.0
30	569	48	19	16	12	0.6
40	556	119	99	21	17	2.5
50	538	206	193	26	24	3.9
60	505	297	285	29	28	4.7
70	469	400	386	33	32	5.5
80	438	478	464	36	35	5.8
90	400	536	521	39	36	5.8
100	371	592	577	42	38	5.8
110	340	653	638	44	40	5.8
120	313	704	689	47	41	5.7
130	289	746	731	50	42	5.6
140	269	778	763	52	44	5.4

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, NATURAL, FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	2385	11	0	5	4	0.0
20	2312	28	0	7	7	0.0
30	2186	101	29	12	12	1.0
40	1885	230	157	17	20	3.9
50	1522	353	290	21	27	5.8
60	1251	419	371	24	29	6.2
70	1027	470	429	26	31	6.1
80	848	527	494	29	33	6.2
90	716	566	541	32	35	6.0
100	617	604	582	35	36	5.8
110	533	635	615	37	37	5.6
120	468	670	651	40	38	5.4
130	416	704	686	42	39	5.3
140	372	731	714	45	41	5.1

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, NATURAL, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	2385	11	0	5	4	0.0
20	2312	28	0	7	7	0.0
30	569	66	34	18	13	1.1
40	558	145	128	23	19	3.2
50	531	244	231	28	23	4.6
60	500	325	312	31	26	5.2
70	465	405	391	34	30	5.6
80	429	482	467	38	33	5.8
90	396	544	529	40	34	5.9
100	365	596	581	43	36	5.8
110	333	650	635	45	37	5.8
120	307	708	693	48	40	5.8
130	282	755	739	51	41	5.7
140	260	792	776	53	42	5.5

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	994	5	0	5	4	0.0
20	983	17	0	8	7	0.0
30	965	63	13	14	12	0.4
40	927	147	90	18	20	2.2
50	880	228	192	22	24	3.8
60	809	315	288	25	28	4.8
70	742	400	380	27	30	5.4
80	671	487	468	30	33	5.9
90	609	541	523	32	36	5.8
100	542	602	584	35	38	5.8
110	491	646	629	37	39	5.7
120	445	686	670	39	41	5.6
130	400	717	700	41	42	5.4
140	362	751	735	44	44	5.3

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, PLANTED, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	994	5	0	5	4	0.0
20	983	17	0	8	7	0.0
30	578	50	14	15	12	0.5
40	562	125	93	20	20	2.3
50	545	195	180	24	24	3.6
60	514	276	263	27	28	4.4
70	487	363	349	30	32	5.0
80	451	437	423	33	36	5.3
90	420	514	500	35	38	5.6
100	387	562	548	38	40	5.5
110	351	613	599	40	43	5.4
120	325	646	632	42	45	5.3
130	298	689	675	44	47	5.2
140	273	731	717	47	49	5.1

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, PLANTED, FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	994	5	0	5	4	0.0
20	983	17	0	8	7	0.0
30	965	81	27	15	13	0.9
40	927	175	120	20	21	3.0
50	871	263	230	23	25	4.6
60	803	339	312	25	28	5.2
70	731	407	385	28	30	5.5
80	662	484	466	30	33	5.8
90	596	561	543	33	35	6.0
100	536	630	612	36	39	6.1
110	482	682	665	38	41	6.0
120	436	712	695	40	42	5.8
130	393	757	741	42	44	5.7
140	353	791	775	45	45	5.5

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, PLANTED, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	994	5	0	5	4	0.0
20	983	17	0	8	7	0.0
30	578	67	26	17	13	0.9
40	565	152	121	22	22	3.0
50	542	227	211	25	24	4.2
60	511	299	286	28	28	4.8
70	476	406	392	32	35	5.6
80	445	485	471	35	38	5.9
90	409	563	548	37	41	6.1
100	378	616	601	40	43	6.0
110	342	687	672	43	46	6.1
120	313	731	716	45	47	6.0
130	289	764	749	47	48	5.8
140	269	780	766	49	49	5.5

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, NATURAL/PLANTED, OVERTOPPED NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	800	1	0	3	3	0.0
20	766	5	0	5	5	0.0
30	711	9	0	6	7	0.0
40	558	11	0	7	9	0.0
50	422	12	0	8	11	0.0
60	319	14	5	9	12	0.1
70	249	16	6	11	14	0.1
80	183	22	11	14	17	0.1
90	143	24	17	16	21	0.2
100	121	25	22	17	22	0.2
110	94	32	24	21	26	0.2
120	82	39	30	25	27	0.3
130	72	46	36	28	29	0.3
140	62	52	42	31	30	0.3

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, NATURAL/PLANTED, CONIFER RELEASE

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	800	1	0	3	3	0.0
20	783	8	0	7	6	0.0
30	773	33	5	12	10	0.2
40	746	86	44	17	16	1.1
50	719	152	120	21	20	2.4
60	682	253	235	25	24	3.9
70	647	340	324	28	27	4.6
80	603	421	405	31	30	5.1
90	556	494	478	34	32	5.3
100	509	567	550	36	34	5.5
110	472	624	607	39	36	5.5
120	430	676	659	41	37	5.5
130	395	725	708	43	39	5.4
140	363	762	745	45	40	5.3

OPERATIONAL YIELD TABLES

COASTAL DOUGLAS-FIR

MEDIUM SITE, NATURAL/PLANTED, BRUSHED IN

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	342	0	0	1	2	0.0
20	328	1	0	2	5	0.0
30	315	7	0	4	8	0.0
40	315	30	14	6	13	0.4
50	309	74	54	10	19	1.1
60	309	131	109	13	25	1.8
70	300	202	181	18	28	2.6
80	283	267	242	23	31	3.0
90	275	324	296	28	34	3.3
100	260	395	361	34	36	3.6
110	244	459	422	39	38	3.8
120	231	509	468	43	40	3.9
130	212	573	528	47	41	4.1
140	202	616	568	50	43	4.1

OPERATIONAL YIELD TABLES

COASTAL WESTERN HEMLOCK

GOOD SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	2637	10	0	5	5	0.0
20	2553	34	0	8	8	0.0
30	2335	137	44	13	13	1.5
40	1686	289	207	19	20	5.2
50	1157	446	392	23	29	7.8
60	888	557	522	27	32	8.7
70	703	672	645	32	35	9.2
80	586	793	769	36	38	9.6
90	504	905	881	39	41	9.8
100	439	1013	990	43	43	9.9
110	388	1113	1091	46	45	9.9
120	353	1195	1172	49	47	9.8
130	321	1268	1246	52	49	9.6
140	292	1341	1319	55	51	9.4

OPERATIONAL YIELD TABLES

COASTAL WESTERN HEMLOCK

GOOD SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	2637	10	0	5	5	0.0
20	2553	34	0	8	8	0.0
30	578	71	41	18	12	1.4
40	567	194	175	24	20	4.4
50	542	363	345	29	28	6.9
60	507	543	524	34	32	8.7
70	469	695	674	38	35	9.6
80	429	838	817	42	38	10.2
90	389	967	946	45	41	10.5
100	358	1068	1047	48	43	10.5
110	325	1174	1152	51	45	10.5
120	300	1257	1235	54	47	10.3
130	269	1363	1341	58	49	10.3
140	249	1432	1410	61	51	10.1

OPERATIONAL YIELD TABLES

COASTAL WESTERN HEMLOCK

GOOD SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	989	5	0	6	5	0.0
20	974	18	1	9	8	0.0
30	940	84	36	16	13	1.2
40	858	214	178	22	21	4.4
50	738	395	367	27	28	7.3
60	627	565	543	33	32	9.0
70	551	702	679	36	35	9.7
80	485	844	821	40	38	10.3
90	436	962	940	44	41	10.4
100	398	1056	1033	46	42	10.3
110	360	1157	1134	49	45	10.3
120	331	1245	1223	52	47	10.2
130	302	1324	1301	55	49	10.0
140	278	1395	1373	58	51	9.8

OPERATIONAL YIELD TABLES

COASTAL WESTERN HEMLOCK

GOOD SITE, PLANTED, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	989	5	0	6	5	0.0
20	974	18	1	9	8	0.0
30	578	71	36	18	13	1.2
40	567	187	156	24	21	4.2
50	542	383	366	30	28	7.3
60	509	536	517	34	32	8.6
70	469	691	671	38	36	9.6
80	431	825	804	41	38	10.1
90	393	955	934	45	41	10.4
100	360	1064	1043	48	43	10.4
110	327	1172	1150	51	46	10.5
120	298	1270	1248	55	48	10.4
130	271	1358	1336	58	50	10.3
140	251	1428	1406	60	52	10.0

OPERATIONAL YIELD TABLES

COASTAL WESTERN-HEMLOCK

MEDIUM SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	2637	10	0	5	5	0.0
20	2624	11	0	5	5	0.0
30	2519	55	2	10	9	0.1
40	2328	189	72	15	14	1.8
50	1873	369	281	20	20	5.6
60	1461	451	388	23	23	6.5
70	1146	526	477	26	26	6.8
80	915	595	562	29	28	7.0
90	739	661	633	33	31	7.0
100	613	725	700	36	33	7.0
110	519	782	758	39	35	6.9
120	456	834	812	42	37	6.8
130	399	887	865	45	39	6.7
140	353	937	916	47	41	6.5

OPERATIONAL YIELD TABLES

COASTAL WESTERN HEMLOCK

MEDIUM SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	2637	10	0	5	5	0.0
20	2624	11	0	5	5	0.0
30	547	27	3	13	9	0.1
40	536	98	71	20	15	1.8
50	522	191	173	25	20	3.5
60	498	293	278	29	23	4.6
70	473	409	392	34	27	5.6
80	451	520	503	37	28	6.3
90	427	659	639	41	31	7.1
100	402	782	761	44	33	7.6
110	389	849	828	46	34	7.5
120	373	917	896	48	36	7.5
130	358	971	950	49	37	7.3
140	342	1024	1002	51	39	7.2

OPERATIONAL YIELD TABLES

COASTAL WESTERN HEMLOCK

MEDIUM SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	989	4	0	6	5	0.0
20	985	5	0	6	5	0.0
30	954	31	3	11	9	0.1
40	927	118	69	18	14	1.7
50	874	255	224	23	20	4.5
60	787	398	374	28	23	6.2
70	698	536	512	33	26	7.3
80	622	650	626	36	28	7.8
90	558	764	740	40	30	8.2
100	498	869	844	43	33	8.4
110	469	931	906	45	34	8.2
120	438	975	951	46	36	7.9
130	411	1013	990	48	37	7.6
140	385	1053	1030	49	38	7.4

OPERATIONAL YIELD TABLES

COASTAL WESTERN HEMLOCK

MEDIUM SITE, PLANTED, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	989	4	0	6	5	0.0
20	985	5	0	6	5	0.0
30	560	24	3	12	10	0.1
40	547	82	51	19	15	1.3
50	529	191	165	25	21	3.3
60	505	320	305	30	23	5.1
70	473	469	452	36	26	6.5
80	442	604	585	40	29	7.3
90	413	730	709	44	31	7.9
100	389	845	824	47	33	8.2
110	376	914	892	48	35	8.1
120	358	983	960	50	37	8.0
130	340	1043	1020	52	38	7.8
140	325	1090	1067	53	39	7.6

OPERATIONAL YIELD TABLES

COASTAL HEMBAL

GOOD SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	2635	9	0	5	5	0.0
20	2574	27	0	7	7	0.0
30	2465	111	26	12	12	0.9
40	2200	297	179	17	20	4.5
50	1873	504	392	20	29	7.8
60	1552	629	544	23	32	9.1
70	1285	749	684	26	35	9.8
80	1069	855	802	29	37	10.0
90	907	949	911	31	40	10.1
100	768	1040	1006	35	42	10.1
110	663	1122	1091	37	45	9.9
120	573	1198	1170	40	46	9.7
130	500	1271	1244	43	48	9.6
140	441	1336	1310	46	50	9.4

OPERATIONAL YIELD TABLES

COASTAL HEMBAL

GOOD SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	2635	9	0	5	5	0.0
20	2574	27	0	7	7	0.0
30	578	63	23	17	13	0.8
40	567	172	152	23	19	3.8
50	545	371	353	29	28	7.1
60	511	536	517	34	32	8.6
70	473	687	667	37	36	9.5
80	429	844	823	42	38	10.3
90	393	973	952	45	41	10.6
100	351	1105	1083	49	44	10.8
110	322	1200	1179	52	46	10.7
120	296	1290	1268	55	48	10.6
130	271	1373	1351	58	50	10.4
140	249	1443	1421	61	52	10.1

OPERATIONAL YIELD TABLES

COASTAL HEMBAL

MEDIUM SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	2637	10	0	5	4	0.0
20	2622	11	0	5	5	0.0
30	2501	56	2	10	9	0.1
40	2314	188	70	15	14	1.8
50	1913	351	256	19	20	5.1
60	1489	448	385	22	22	6.4
70	1178	523	474	26	25	6.8
80	943	592	554	29	28	6.9
90	777	657	624	32	30	6.9
100	653	714	686	35	32	6.9
110	550	773	748	38	34	6.8
120	481	822	799	41	36	6.7
130	416	875	854	44	38	6.6
140	367	923	902	46	39	6.4

OPERATIONAL YIELD TABLES

COASTAL HEMBAL

MEDIUM SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	2637	10	0	5	4	0.0
20	2622	12	0	5	5	0.0
30	545	19	1	11	9	0.0
40	531	74	45	19	14	1.1
50	518	173	152	25	20	3.0
60	494	286	270	30	23	4.5
70	467	416	399	35	26	5.7
80	436	577	558	40	27	7.0
90	411	697	677	43	29	7.5
100	389	808	787	46	32	7.9
110	373	886	864	49	33	7.9
120	356	942	920	50	35	7.7
130	338	998	976	52	37	7.5
140	320	1068	1045	54	38	7.5

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

GOOD SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	1998	10	0	5	4	0.0
20	1990	20	0	7	5	0.0
30	1958	64	3	11	9	0.1
40	1830	124	31	14	13	0.8
50	1646	188	101	17	17	2.0
60	1446	258	173	19	22	2.9
70	1269	321	267	21	26	3.8
80	1136	361	315	23	27	3.9
90	1004	405	366	25	29	4.1
100	885	450	417	27	30	4.2
110	794	488	457	29	32	4.2
120	707	526	497	30	34	4.1
130	636	561	534	32	36	4.1
140	579	589	564	34	37	4.0

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

GOOD SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	1998	12	0	5	4	0.0
20	1990	20	0	7	5	0.0
30	580	30	3	14	9	0.1
40	569	69	44	18	13	1.1
50	551	125	100	22	18	2.0
60	529	200	184	25	22	3.1
70	502	276	259	29	26	3.7
80	471	343	325	31	28	4.1
90	440	410	392	34	31	4.4
100	411	472	454	37	33	4.5
110	382	526	508	39	35	4.6
120	358	570	551	41	36	4.6
130	338	608	589	43	37	4.5
140	311	653	634	45	39	4.5

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

GOOD SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	991	6	0	5	4	0.0
20	989	11	0	7	5	0.0
30	985	41	1	13	8	0.0
40	956	95	52	17	12	1.3
50	903	172	138	21	18	2.8
60	838	249	217	24	22	3.6
70	765	330	300	27	25	4.3
80	696	397	370	29	27	4.6
90	634	454	428	31	29	4.8
100	574	511	486	34	32	4.9
110	520	563	537	36	34	4.9
120	480	602	579	38	35	4.8
130	442	639	617	40	36	4.7
140	407	673	651	42	37	4.7

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

GOOD SITE, PLANTED, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	991	6	0	5	4	0.0
20	989	11	0	7	5	0.0
30	582	31	1	14	9	0.0
40	571	78	55	19	14	1.4
50	556	125	103	22	17	2.1
60	527	210	191	26	22	3.2
70	502	286	269	29	26	3.8
80	469	359	341	32	28	4.3
90	440	415	396	34	30	4.4
100	411	471	452	37	32	4.5
110	382	526	507	39	34	4.6
120	356	574	555	42	35	4.6
130	331	620	601	44	37	4.6
140	309	665	646	46	39	4.6

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

GOOD SITE, NATURAL/PLANTED, OVERTOPPED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	590	1	0	3	3	0.0
20	576	2	0	4	4	0.0
30	568	5	0	5	6	0.0
40	524	10	0	7	8	0.0
50	447	13	0	9	9	0.0
60	385	16	0	10	11	0.0
70	331	16	0	10	13	0.0
80	282	17	0	11	15	0.0
90	227	19	3	12	17	0.0
100	195	20	3	14	19	0.0
110	165	21	7	15	21	0.1
120	146	27	12	17	23	0.1
130	126	27	16	18	24	0.1
140	116	28	16	19	27	0.1

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

GOOD SITE, NATURAL/PLANTED, CONIFER RELEASE

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	590	1	0	3	3	0.0
20	590	3	0	5	5	0.0
30	588	12	0	9	8	0.0
40	576	33	6	14	10	0.1
50	561	72	33	18	15	0.7
60	546	133	113	22	20	1.9
70	526	199	182	25	23	2.6
80	499	264	248	28	26	3.1
90	474	330	313	31	28	3.5
100	445	396	378	34	30	3.8
110	417	461	443	36	32	4.0
120	388	533	514	39	34	4.3
130	363	590	570	42	36	4.4
140	341	633	613	43	37	4.4

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

MEDIUM SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
23	2006	11	0	5	5	0.0
30	1988	36	0	9	6	0.0
40	1921	85	7	13	9	0.2
50	1745	142	56	16	12	1.1
60	1525	197	132	19	15	2.2
70	1338	241	187	21	17	2.7
80	1162	284	240	23	19	3.0
90	1029	319	280	25	21	3.1
100	907	354	321	27	23	3.2
110	808	385	355	28	24	3.2
120	721	418	392	30	26	3.3
130	650	445	421	32	27	3.2
140	589	472	448	34	29	3.2
150	530	499	476	36	30	3.2

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

MEDIUM SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
23	2006	11	0	5	5	0.0
30	1988	36	0	9	6	0.0
40	580	40	10	16	9	0.2
50	567	76	52	20	12	1.0
60	545	130	115	24	15	1.9
70	520	182	166	27	17	2.4
80	485	247	232	31	20	2.9
90	456	290	273	34	21	3.0
100	422	335	318	36	23	3.2
110	387	385	368	39	25	3.3
120	362	418	401	41	26	3.3
130	340	449	431	43	27	3.3
140	316	481	463	46	28	3.3
150	293	512	494	48	29	3.3

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

MEDIUM SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
23	987	6	0	5	5	0.0
30	980	21	0	10	7	0.0
40	969	53	6	14	9	0.1
50	934	100	54	18	12	1.1
60	885	152	120	21	15	2.0
70	818	213	183	24	17	2.6
80	749	271	247	27	19	3.1
90	689	318	295	29	21	3.3
100	629	362	340	31	23	3.4
110	580	398	377	33	24	3.4
120	527	440	418	36	26	3.5
130	485	473	452	38	27	3.5
140	447	505	484	39	29	3.5
150	416	531	511	41	30	3.4

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

MEDIUM SITE, PLANTED, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
23	987	6	0	5	5	0.0
30	980	21	0	10	7	0.0
40	580	39	6	15	9	0.1
50	567	73	44	19	12	0.9
60	551	109	95	22	15	1.6
70	522	165	151	26	17	2.2
80	496	220	205	29	20	2.6
90	465	269	253	32	21	2.8
100	436	313	297	35	23	3.0
110	405	356	339	37	25	3.1
120	378	393	376	40	26	3.1
130	353	428	410	42	27	3.2
140	331	456	438	44	28	3.1
150	311	484	466	45	29	3.1

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

MEDIUM SITE, NATURAL/PLANTED, OVERTOPPED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
23	590	1	0	3	3	0.0
30	578	4	0	5	5	0.0
40	548	9	0	7	7	0.0
50	506	12	0	8	9	0.0
60	435	15	0	9	11	0.0
70	353	18	0	11	12	0.0
80	296	17	3	11	14	0.0
90	252	19	3	12	16	0.0
100	212	20	3	13	17	0.0
110	183	21	7	14	17	0.1
120	158	22	7	15	18	0.1
130	138	22	12	16	20	0.1
140	126	23	12	17	21	0.1
150	111	23	12	18	23	0.1

OPERATIONAL YIELD TABLES

INTERIOR SPRUCE

MEDIUM SITE, NATURAL/PLANTED, CONIFER RELEASE

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
23	590	1	0	3	3	0.0
30	588	7	0	7	6	0.0
40	583	21	0	12	8	0.0
50	571	47	13	16	11	0.3
60	556	87	60	20	13	1.0
70	536	133	116	24	16	1.7
80	511	185	170	27	17	2.1
90	482	246	230	31	20	2.6
100	454	293	276	34	22	2.8
110	422	347	330	37	23	3.0
120	393	395	377	39	25	3.1
130	366	436	418	42	26	3.2
140	343	471	453	44	27	3.2
150	321	504	485	46	28	3.2

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

GOOD SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	6539	26	0	5	5	0.0
20	6126	66	0	7	7	0.0
30	5349	152	0	9	12	0.0
40	4102	235	0	11	16	0.0
50	3120	305	19	13	20	0.4
60	2357	375	92	14	25	1.5
70	1826	438	221	17	28	3.2
80	1456	446	291	18	29	3.6
90	1174	458	355	20	30	3.9
100	968	472	403	22	31	4.0
110	810	481	439	24	32	4.0

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

GOOD SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	6539	26	0	5	5	0.0
20	6126	66	0	7	7	0.0
30	1289	75	0	12	12	0.0
40	1174	147	16	15	17	0.4
50	1063	236	120	17	21	2.4
60	958	325	244	20	25	4.1
70	847	408	367	22	29	5.2
80	740	442	414	24	30	5.2
90	642	462	438	26	31	4.9
100	556	483	466	28	32	4.7
110	491	496	481	30	32	4.4

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

GOOD SITE, NATURAL, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	6539	26	0	5	5	0.0
20	6126	66	0	7	7	0.0
30	1294	92	1	13	13	0.0
40	1207	176	49	15	18	1.2
50	1080	265	154	18	22	3.1
60	963	369	311	21	26	5.2
70	851	436	399	23	28	5.7
80	740	466	444	25	30	5.5
90	642	494	475	27	31	5.3
100	562	519	501	29	32	5.0
110	491	530	514	31	33	4.7

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

GOOD SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	1438	7	0	5	5	0.0
20	1420	31	0	9	8	0.0
30	1387	92	0	12	13	0.0
40	1260	172	38	15	19	1.0
50	1125	254	121	18	23	2.4
60	987	341	258	20	26	4.3
70	876	415	374	22	29	5.3
80	754	453	429	24	30	5.4
90	658	488	468	27	31	5.2
100	569	509	491	29	32	4.9
110	496	521	504	31	33	4.6

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

GOOD SITE, PLANTED, FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
14	1438	7	0	5	5	0.0
20	1420	31	0	9	8	0.0
30	1385	112	4	13	14	0.1
40	1287	201	74	16	20	1.8
50	1145	280	165	18	23	3.3
60	1003	367	289	20	26	5.0
70	869	441	389	23	29	5.7
80	756	478	437	25	30	5.6
90	658	513	472	27	30	5.5
100	569	532	490	29	31	4.1
110	493	546	502	31	32	4.8

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

MEDIUM SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	6539	26	0	5	4	0.0
20	6307	41	0	6	5	0.0
30	5560	94	0	8	9	0.0
40	4369	159	0	10	12	0.0
50	3320	222	15	12	15	0.3
60	2541	276	60	14	18	1.0
70	1956	326	138	16	21	2.0
80	1555	349	210	18	22	2.6
90	1263	365	273	20	23	3.0
100	1041	379	319	22	24	3.2
110	869	390	347	23	25	3.2

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

MEDIUM SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	6539	26	0	5	4	0.0
20	6307	41	0	6	5	0.0
30	1192	48	0	11	9	0.0
40	1107	102	2	14	13	0.1
50	1007	163	69	17	16	1.4
60	916	231	174	20	18	2.9
70	823	295	256	22	21	3.7
80	727	335	316	24	22	3.9
90	647	371	354	26	23	3.9
100	569	408	392	29	25	3.9
110	507	431	415	31	25	3.8

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

MEDIUM SITE, NATURAL, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	6539	26	0	5	4	0.0
20	6307	41	0	6	5	0.0
30	1194	66	7	12	10	0.2
40	1132	133	37	15	14	0.9
50	1047	204	123	19	16	2.5
60	947	273	238	21	19	4.0
70	854	334	311	23	21	4.4
80	749	369	350	25	23	4.4
90	658	398	380	27	23	4.2
100	574	428	411	30	24	4.1
110	514	453	437	32	25	4.0

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

MEDIUM SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	1438	7	0	5	5	0.0
20	1425	16	0	7	6	0.0
30	1394	60	0	11	10	0.0
40	1298	116	8	14	12	0.2
50	1167	181	82	17	16	1.6
60	1043	252	186	20	18	3.1
70	927	316	283	22	20	4.0
80	814	356	333	24	21	4.2
90	711	389	369	27	22	4.1
100	620	414	397	29	23	4.0
110	540	432	416	31	24	3.8

OPERATIONAL YIELD TABLES

INTERIOR LODGEPOLE PINE

MEDIUM SITE, PLANTED, FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
17	1438	7	0	5	5	0.0
20	1425	16	0	7	6	0.0
30	1392	86	10	12	11	0.3
40	1323	150	30	15	14	0.7
50	1183	210	103	18	16	2.1
60	1047	277	227	21	19	3.8
70	927	342	312	23	20	4.5
80	815	382	359	25	21	4.5
90	711	419	390	28	22	4.3
100	620	440	421	30	23	4.2
110	540	456	438	32	24	4.0

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

GOOD SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	2237	12	0	5	4	0.0
20	2227	14	0	5	5	0.0
30	2148	45	1	9	8	0.0
40	1978	108	19	13	12	0.5
50	1715	194	103	16	18	2.1
60	1468	272	200	19	23	3.3
70	1249	343	281	21	27	4.0
80	1063	415	354	23	30	4.4
90	905	489	434	26	35	4.8
100	777	553	517	28	38	5.2
110	668	618	589	30	42	5.4
120	581	668	643	32	45	5.4
130	508	711	692	34	48	5.3
140	443	758	741	37	50	5.3

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

GOOD SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	2237	12	0	5	4	0.0
20	2227	14	0	5	5	0.0
30	551	23	2	12	9	0.1
40	534	65	30	17	13	0.8
50	518	122	99	21	18	2.0
60	494	181	163	24	23	2.7
70	462	252	240	27	27	3.4
80	429	317	304	30	30	3.8
90	400	382	370	33	34	4.1
100	367	448	436	35	37	4.4
110	340	499	487	37	41	4.4
120	311	548	535	39	43	4.5
130	287	595	583	41	46	4.5
140	265	634	621	43	48	4.4

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

GOOD SITE, NATURAL, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	2237	12	0	5	4	0.0
20	2227	14	0	5	5	0.0
30	551	27	7	13	9	0.2
40	534	91	65	20	15	1.6
50	518	157	139	24	19	2.8
60	489	215	201	27	23	3.3
70	451	274	261	30	26	3.7
80	422	339	326	32	29	4.1
90	389	397	383	34	33	4.3
100	353	466	454	37	36	4.5
110	327	533	520	40	39	4.7
120	302	589	576	42	41	4.8
130	280	637	624	44	44	4.8
140	256	686	673	47	47	4.8

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

GOOD SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	985	6	0	5	4	0.0
20	983	7	0	6	5	0.0
30	969	30	1	10	9	0.0
40	934	79	18	15	13	0.5
50	889	141	93	18	18	1.9
60	825	223	183	22	23	3.0
70	765	299	273	24	27	3.9
80	696	372	351	26	30	4.4
90	627	453	434	29	34	4.8
100	567	522	504	31	37	5.0
110	511	587	570	33	41	5.2
120	458	650	633	35	44	5.3
130	413	703	687	38	47	5.3
140	376	758	742	40	50	5.3

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

GOOD SITE, PLANTED, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	985	6	0	5	4	0.0
20	983	7	0	6	5	0.0
30	574	22	1	11	9	0.0
40	558	60	29	17	13	0.7
50	540	115	92	21	18	1.8
60	514	190	174	24	23	2.9
70	487	257	242	27	27	3.5
80	451	332	320	30	30	4.0
90	420	398	386	32	34	4.3
100	380	461	449	35	38	4.5
110	349	523	511	37	41	4.6
120	320	580	567	40	43	4.7
130	293	636	623	42	46	4.8
140	271	680	667	44	48	4.8

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

GOOD SITE, PLANTED, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
19	985	6	0	5	4	0.0
20	983	7	0	6	5	0.0
30	574	24	3	12	9	0.1
40	558	87	60	20	14	1.5
50	542	145	124	23	19	2.5
60	511	212	199	26	23	3.3
70	480	277	265	29	27	3.8
80	445	335	323	31	29	4.0
90	409	392	379	34	32	4.2
100	376	458	446	36	35	4.5
110	347	518	505	38	38	4.6
120	318	572	559	41	41	4.7
130	293	617	604	43	43	4.6
140	267	665	652	45	46	4.6

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

MEDIUM SITE, NATURAL, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
21	2241	11	0	5	4	0.0
30	2172	42	2	9	7	0.1
40	2053	94	16	12	10	0.4
50	1776	151	69	15	14	1.4
60	1523	209	119	18	18	2.0
70	1296	262	203	20	21	2.9
80	1099	321	278	22	25	3.5
90	941	365	329	24	27	3.7
100	810	403	373	26	30	3.7
110	694	451	424	28	33	3.9
120	609	491	466	30	35	3.9
130	532	528	507	33	37	3.9
140	466	557	540	35	40	3.9
150	415	584	568	37	41	3.8

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

MEDIUM SITE, NATURAL, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
21	2241	11	0	5	4	0.0
30	2172	42	2	9	7	0.1
40	571	51	18	16	10	0.5
50	549	103	72	21	15	1.4
60	527	166	153	24	18	2.6
70	498	228	215	27	21	3.1
80	465	289	276	30	24	3.4
90	427	341	329	33	27	3.7
100	387	399	386	36	30	3.9
110	360	452	439	38	32	4.0
120	329	491	478	40	34	4.0
130	300	518	506	42	37	3.9
140	273	548	536	45	39	3.8
150	249	566	554	47	41	3.7

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

MEDIUM SITE, NATURAL, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
21	2241	11	0	5	4	0.0
30	2172	42	2	9	7	0.1
40	571	73	40	19	11	1.0
50	554	130	116	23	15	2.3
60	522	197	182	27	18	3.0
70	485	259	246	30	21	3.5
80	442	312	299	33	23	3.7
90	402	366	353	36	27	3.9
100	367	411	399	38	28	4.0
110	336	462	449	41	31	4.1
120	309	497	484	43	33	4.0
130	280	519	506	45	35	3.9
140	251	548	535	47	37	3.8
150	231	567	555	49	38	3.7

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

MEDIUM SITE, PLANTED, NO TREATMENT

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
21	989	5	0	5	4	0.0
30	969	23	0	9	8	0.0
40	940	66	14	14	11	0.3
50	898	122	71	18	14	1.4
60	840	186	141	21	18	2.3
70	765	256	229	24	21	3.3
80	700	318	296	27	24	3.7
90	629	363	347	29	27	3.9
100	567	407	391	31	29	3.9
110	509	452	436	33	31	4.0
120	458	503	488	36	33	4.1
130	416	547	532	38	35	4.1
140	373	583	568	40	37	4.1
150	342	617	603	42	40	4.0

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

MEDIUM SITE, PLANTED, SPACED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
21	989	5	0	5	4	0.0
30	969	23	0	10	8	0.0
40	576	50	14	15	11	0.3
50	558	96	70	20	15	1.4
60	538	141	128	23	18	2.1
70	505	195	184	26	21	2.6
80	473	248	236	29	23	3.0
90	438	302	290	32	25	3.2
100	411	348	336	34	27	3.4
110	380	393	381	36	29	3.5
120	349	434	422	39	31	3.5
130	322	476	463	41	33	3.6
140	296	515	503	43	35	3.6
150	271	552	539	46	37	3.6

OPERATIONAL YIELD TABLES

INTERIOR WET-BELT DOUGLAS-FIR

MEDIUM SITE, PLANTED, SPACED & FERTILIZED

TOTAL AGE	TREES /HA	VOLUME / HA TOTAL CU M	VOLUME / HA MERCH CU M	QDBH CM	TOP HT M	MERCH MAI CU M /YR
21	989	5	0	5	4	0.0
30	969	23	0	10	8	0.0
40	574	81	59	20	12	1.5
50	558	136	120	24	15	2.4
60	525	193	182	27	18	3.0
70	489	245	233	30	20	3.3
80	451	293	281	33	23	3.5
90	411	342	329	36	25	3.7
100	382	385	372	38	27	3.7
110	349	431	418	40	29	3.8
120	320	474	461	43	31	3.8
130	296	513	500	45	32	3.8
140	271	537	524	47	34	3.7
150	247	562	549	49	36	3.7